

CMA US Notes: Learning Curves, Top-Level Planning, and Business Combinations

Learning Curves

Overview

Learning curves describe the phenomenon where the time required to perform a repetitive task decreases as workers gain experience, improving efficiency. This is particularly relevant for labor-intensive processes.

- **Definition:** A mathematical model showing that the time per unit decreases as the cumulative number of units produced increases, due to learning and process improvements.
- **Key Concept:** Learning occurs most significantly when production doubles, with efficiency improvements expressed as a percentage (e.g., 80% learning curve means the time per unit is 80% of the previous doubling's time).

Doubling of Production

- **Assumption:** Learning effects are most measurable at each doubling of production (e.g., 1 to 2 units, 2 to 4 units, 4 to 8 units).
- **Impact:** Each doubling reduces the cumulative average time per unit by a fixed percentage, reflecting improved efficiency.

Cumulative Average-Time Learning Model

- **Definition:** Calculates the average time per unit for all units produced to date, assuming a learning rate applies at each doubling.
- **Calculations:**
 1. **Total Time:** $\text{Total Time} = \text{Cumulative Average Time per Unit} \times \text{Number of Units}$
 2. **Cumulative Average Time per Unit:** $T_n = T_1 \times (n^b)$
 - T_1 : Time to produce the first unit.
 - n : Cumulative number of units.
 - $b = \frac{\ln(\text{Learning Rate})}{\ln(2)}$, where the learning rate is expressed as a decimal (e.g., 80% = 0.8).
 3. **Time for a Block of Units:** Difference between total time for two cumulative quantities (e.g., units 1–8 minus units 1–4 for units 5–8).
- **Example (Automobile Manufacturing):**
 - Learning rate: 80% (0.8).
 - Time for first unit (T_1): 10 hours.
 - For 2 units:
 - Cumulative average time per unit = $10 \times (2^{\frac{\ln(0.8)}{\ln(2)}}) = 10 \times (2^{-0.3219}) = 10 \times 0.8 = 8$ hours.

- Total time = $(8 \times 2 = 16)$ hours.

- For 4 units:

- Cumulative average time per unit = $(10 \times (4^{\frac{\ln(0.8)}{\ln(2)}}) = 10 \times (4^{-0.3219}) = 10 \times 0.64 = 6.4$ hours.

- Total time = $(6.4 \times 4 = 25.6)$ hours.

- For 8 units:

- Cumulative average time per unit = $(10 \times (8^{\frac{\ln(0.8)}{\ln(2)}}) = 10 \times (8^{-0.3219}) = 10 \times 0.512 = 5.12$ hours.

- Total time = $(5.12 \times 8 = 40.96)$ hours.

- Time for units 5–8 = $(40.96 - 25.6 = 15.36)$ hours.

Questions (Solutions)

1. Cumulative Average Time per Unit After 8 Lots:

- From above, cumulative average time per unit for 8 units = 5.12 hours.
- **Answer:** 5.12 hours per unit.

2. Incremental Variable Cost for the 8th Lot:

- Assumes “lot” refers to a single unit for simplicity, as the problem does not specify lot size.
- Total time for 7 units:
 - Cumulative average time = $(10 \times (7^{\frac{\ln(0.8)}{\ln(2)}}) = 10 \times (7^{-0.3219}) \approx 5.285$ hours.
 - Total time = $(5.285 \times 7 \approx 36.995)$ hours.
- Time for 8th unit = $(40.96 - 36.995 \approx 3.965)$ hours.
- Assuming variable cost is labor at \$20/hour (example rate), cost = $(3.965 \times 20 = \$79.30)$.
- **Answer:** \$79.30 (assuming labor cost context).

Benefits of Learning Curves

- **Make-or-Buy Decisions:** Quantifies labor cost savings, aiding decisions on in-house production versus outsourcing.
- **Cost Estimation:** Predicts future labor costs for budgeting and pricing.
- **Process Improvement:** Identifies efficiency gains, supporting operational planning.

Limitations of Learning Curves

- **Applicability:** Relevant only for labor-intensive, repetitive tasks where experience drives improvement.

- **Data Dependency:** Requires historical data to establish learning rates.
- **Static Assumptions:** May not account for changes in technology, workforce, or processes.

Top-Level Planning and Analysis

Pro Forma Financial Statements

- **Definition:** Forecasted financial statements (income statement, balance sheet, cash flow statement) prepared for internal planning.
- **Purpose:** Project future financial performance to guide strategic decisions and resource allocation.
- **Preparation:**
 - **Income Statement:** Forecast revenues, expenses, and net income.
 - **Balance Sheet:** Project assets, liabilities, and equity based on operational and financing plans.
 - **Cash Flow Statement:** Derived from income statement and balance sheet changes.
- **Common Reasons:**
 1. Compare anticipated performance with target goals and investor expectations.
 2. Assess financial feasibility of strategic initiatives (e.g., acquisitions, expansions).
 3. Support budgeting and resource allocation decisions.

Forecasting in Planning

- **Approaches:**
 1. **Quantitative Forecasting:** Uses historical data (e.g., time series, regression analysis).
 2. **Qualitative Forecasting:** Relies on expert judgment or market research.
 3. **Hybrid Forecasting:** Combines quantitative and qualitative methods for robust predictions.
- **Sales Forecasting:**
 - Challenging due to external factors (e.g., economic conditions, competition).
 - Uses techniques like regression analysis, market surveys, or trend extrapolation.
- **Forecasting Future Financing Needs:**
 - **Additional Funds Needed (AFN) Formula:**

$$[\text{Projected Increase in Assets}] - [\text{Increase in Spontaneous Liabilities}] - [\text{Increase in Retained Earnings}]$$
 - **Projected Increase in Assets:**

- Assumes assets (e.g., accounts receivable, inventory, fixed assets) maintain historical ratios to sales.
- Formula: $(\text{Increase in Assets}) = \left(\frac{\text{Assets}}{\text{Past Sales}} \right) \times \Delta \text{Sales}$

○ Increase in Spontaneous Liabilities:

- Liabilities (e.g., accounts payable, accruals) that increase with sales.
- Formula: $(\text{Increase in Spontaneous Liabilities}) = \left(\frac{\text{Liabilities}}{\text{Past Sales}} \right) \times \Delta \text{Sales}$

○ Increase in Retained Earnings:

- Formula: $(\text{Increase in Retained Earnings}) = (\text{Profit Margin}) \times (\text{Projected Sales}) \times (\text{Retention Ratio})$
- Retention Ratio = 1 - Dividend Payout Ratio.

○ Example (ABC Industries):

- Previous year sales: \$150,000
- Forecasted sales increase: 10% (\$15,000)
- Assets: Accounts receivable (\$16,800), Inventory (\$18,800), Fixed assets (\$48,450)
- Total assets = \$84,050
- Asset-to-sales ratio = $\left(\frac{84,050}{150,000} \right) \approx 0.5603$
- Projected increase in assets = $(0.5603 \times 15,000) \approx \$8,405$
- Note: Spontaneous liabilities and retained earnings data incomplete in example.

Forecasting Financial Statements

- **Process:**
 1. **Analyze Historical Ratios:** Identify trends in asset, liability, and profitability ratios.
 2. **Forecast Income Statement:** Project revenues, costs, and net income based on sales forecasts.
 3. **Forecast Balance Sheet:** Estimate operating assets, liabilities, and equity.
 4. **Forecast Cash Flow Statement:** Derive from income statement and balance sheet changes.
- **Determinants of External Financing:**
 - Sales growth rate drives asset and liability increases.
 - Higher growth requires more external financing if internal funds (retained earnings, spontaneous liabilities) are insufficient.

Business Combinations and Consolidations: Example Problem

Problem

Scenario: On January 1, 2025, Parent Co. acquires 100% of Sub Co. for \$15,000,000 in cash to expand into the automobile manufacturing market. Sub Co.'s net assets have a fair value of \$12,000,000, including a manufacturing patent valued at \$2,500,000 with a 10-year useful life. Sub Co.'s assembly process follows an **80% learning curve**, with the first unit requiring 20 hours at \$30/hour labor cost. Parent Co. forecasts Sub Co.'s sales at \$20,000,000 (10% increase from \$18,181,818 last year), with assets of \$10,000,000 and spontaneous liabilities of \$2,000,000 last year. Using the **Additional Funds Needed (AFN)** formula (assume profit margin 5%, retention ratio 60%), calculate goodwill, prepare the consolidation journal entry under US GAAP, estimate labor costs for 8 units using the learning curve, and compute AFN. Discuss how learning curves and forecasting support post-acquisition budgeting.

Solution:

1. Goodwill Calculation:

- Purchase price: \$15,000,000
- Fair value of net assets: \$12,000,000
- Goodwill = \$15,000,000 - \$12,000,000 = **\$3,000,000**

2. Consolidation Journal Entry (US GAAP):

3. Dr Assets (excluding patent) 9,500,000

4. Dr Patent 2,500,000

5. Dr Goodwill 3,000,000

6. Cr Cash 15,000,000

7. Amortization of Patent (Year 1, US GAAP):

- Annual amortization = \$2,500,000 ÷ 10 years = \$250,000

8. Dr Amortization Expense 250,000

9. Cr Accumulated Amortization 250,000

10. Labor Costs for 8 Units (Learning Curve):

- Learning rate: 80% (0.8), ($b = \frac{\ln(0.8)}{\ln(2)} \approx -0.3219$).
- First unit: 20 hours.
- Cumulative average time for 8 units = ($20 \times (8^{-0.3219}) \approx 20 \times 0.512 = 10.24$) hours/unit.
- Total time for 8 units = ($10.24 \times 8 = 81.92$) hours.
- Labor cost = ($81.92 \times 30 = \$2,457.60$).
- **Answer:** Total labor cost for 8 units = \$2,457.60.

11. Additional Funds Needed (AFN):

- Sales increase = \$20,000,000 - \$18,181,818 = \$1,818,182.
- Asset-to-sales ratio = ($\frac{10,000,000}{18,181,818} \approx 0.55$).
- Increase in assets = ($0.55 \times 1,818,182 \approx \$1,000,000$).
- Spontaneous liabilities-to-sales ratio = ($\frac{2,000,000}{18,181,818} \approx 0.11$).
- Increase in spontaneous liabilities = ($0.11 \times 1,818,182 \approx \$200,000$).
- Increase in retained earnings = ($0.05 \times 20,000,000 \times 0.6 = \$600,000$).
- AFN = ($1,000,000 - 200,000 - 600,000 = \$200,000$).

12. Strategic and Budgeting Notes:

- **Learning Curves:** The 80% learning curve reduces labor costs to \$2,457.60 for 8 units, informing the **direct labor budget** and improving cost efficiency in Sub Co.'s production process.
- **Forecasting (AFN):** The \$200,000 AFN indicates external financing needs, guiding Parent Co.'s financial planning for Sub Co.'s growth. The sales forecast (\$20,000,000) supports the **sales budget**, aligning resources with market expansion goals.
- **Post-Acquisition Budgeting:** Learning curves optimize labor cost projections, while AFN ensures sufficient funding, supporting the **master budget**. Variance analysis (e.g., comparing actual labor costs to \$2,457.60) facilitates **control**.
- **Consolidation:** Eliminate Sub Co.'s equity accounts. Goodwill is tested annually for impairment, and the patent is amortized under US GAAP.
- **Strategic Alignment:** Learning curves and forecasting ensure Sub Co.'s operations are cost-efficient and financially sustainable, supporting Parent Co.'s strategic objectives in the automobile market.